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(71) Applicant(s)

Pilkington PE Limited

(Incorporated in the United Kingdom)

Glascoed Road, ST ASAPH, Clwyd, LL17 0LL,
United Kingdom

(72) Inventor(s)

Ian Dugid Mearns

George Hood

Frank Urwin

(74) Agent and/or Address for Service

Cruikshank & Fairweather

19 Royal Exchange Square, GLASGOW, G1 3AE,
United Kingdom

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(54) Adjustment arrangement

(57) A tilt adjustment arrangement (10) comprises a housing (11), an eccentric member (13) and a mounting member (16). The eccentric member (13) is rotatable about the housing bearing axis (18) and mounting member (16) is rotatable about the eccentric bearing axis (19) and provides a mounting for an item such as mirror 21 to be adjusted (20). Rotation of the eccentric member (13) relative to the housing (11) and of the mounting member (16) relative to the eccentric member (13) both change the angular disposition of the mounted item (20) relative to the housing (11). A second eccentric member may be interred between the eccentric member and the mounting member (figure 2, not shown). The mirror 21 may be part of a gun muzzle reference system (figure 3, not shown).

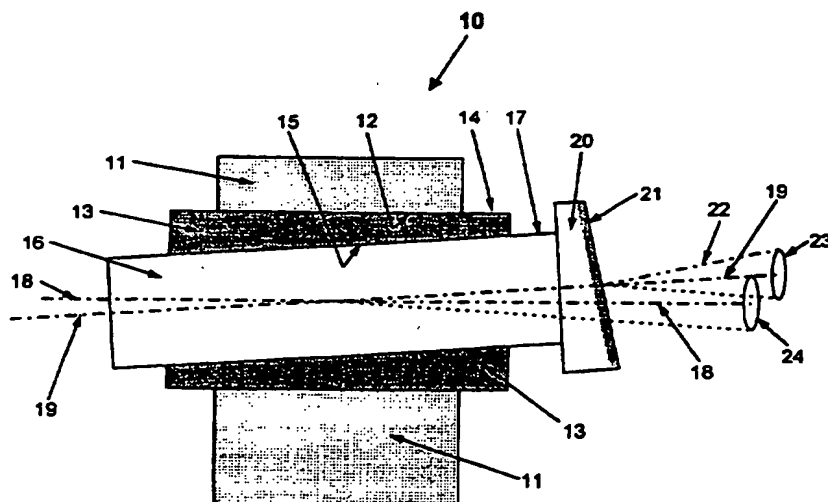


Figure 1

GB 2 305 232 A

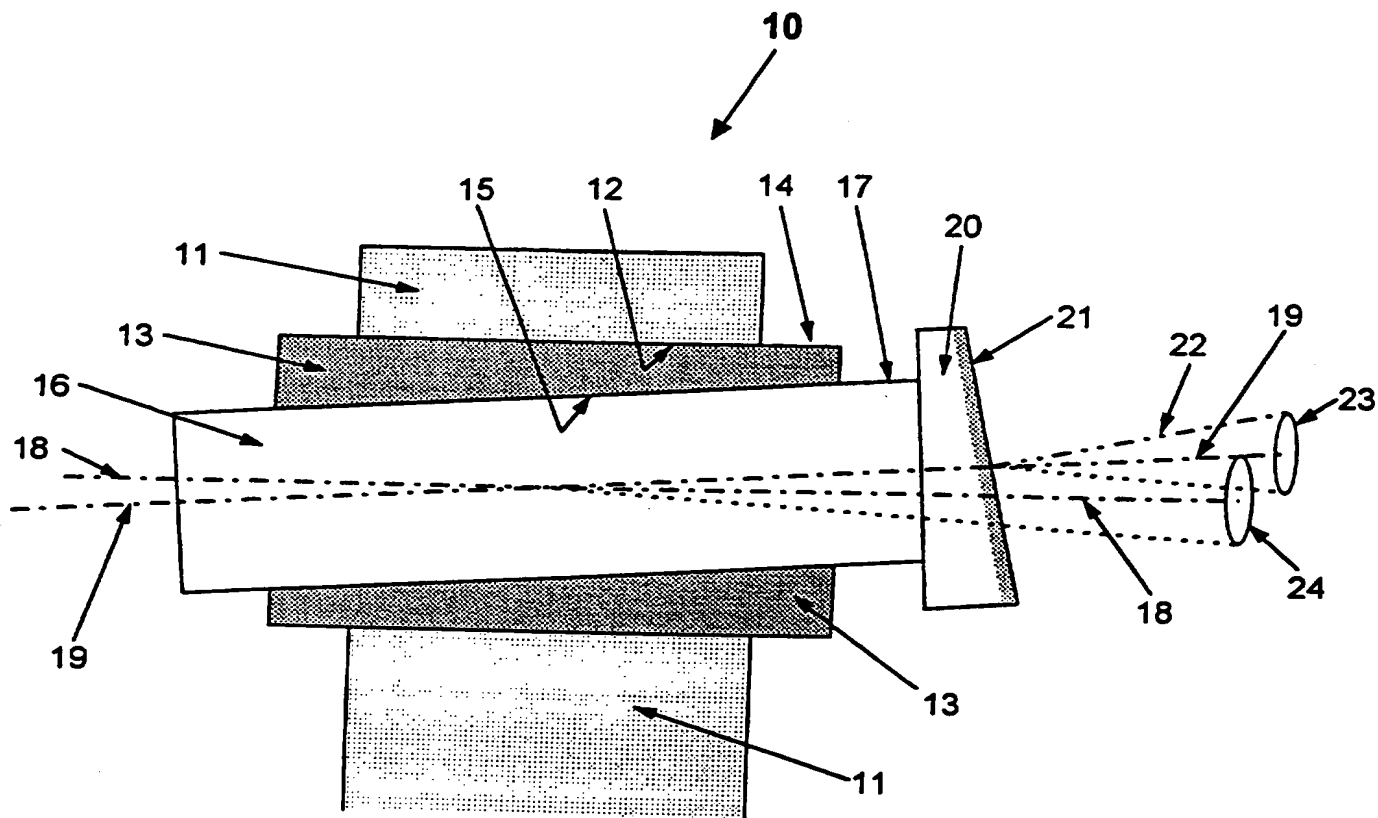


Figure 1

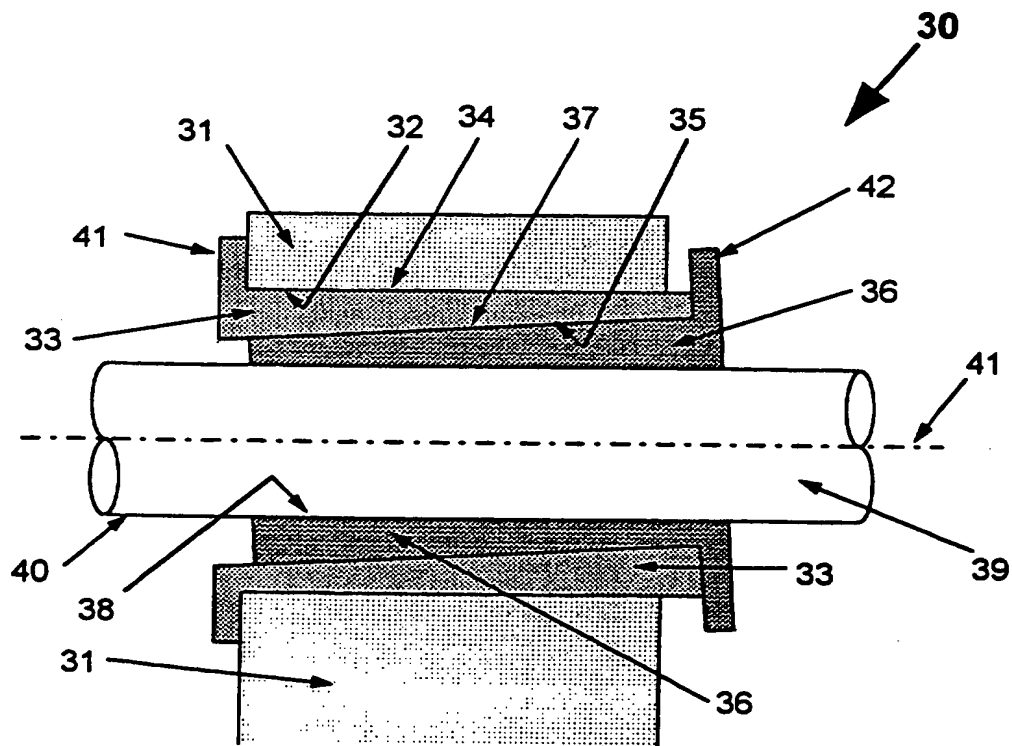


Figure 2

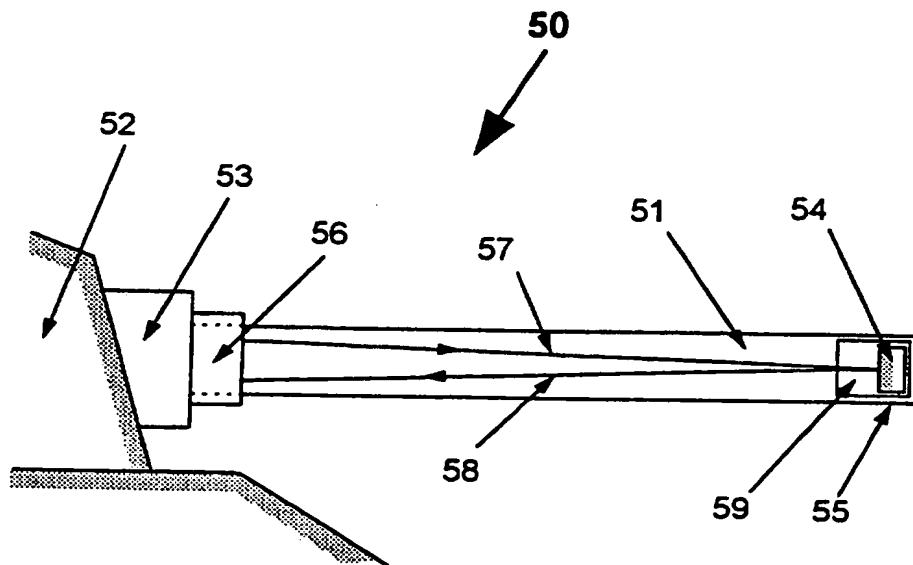


Figure 3

ADJUSTMENT ARRANGEMENT

This invention relates to an adjustment arrangement, and in particular to a tilt adjustment arrangement. The invention is useful in the adjustment of optical systems, but may also be used in a wide variety of other applications.

In various optical systems it is desired to provide tilt adjustment of a system element, for example, in the adjustment of the optical systems utilised in muzzle reference systems, one example of such a system being described in GB 1,587,714. In such systems an optical device, typically a mirror, may be mounted on the muzzle end of a gun and operate in conjunction with auxiliary optics mounted on the non-recoiling part of the weapon, to determine the actual pointing direction of the gun muzzle immediately prior to the instant of firing.

It is generally the case, especially with larger calibre weapons, that the restrictions on size of the muzzle mounted optics and the auxiliary optics, together with the long length of the barrel, necessitate adjustment of the optical system after installation. This normally involves tilting the axis of the muzzle mirror, perhaps by tens of milliradians. Further, in view of the hostile environment experienced by the muzzle mounted optics, which will be exposed to large shocks, high temperatures and reactive gases, the adjustment arrangement must be robust and remain secure in these difficult circumstances.

It is possible that conventional mechanical adjustment mechanisms, such as eccentric bushings mounted on some form of spherical seating, could provide the desired range of adjustment, however it is considered that the manufacture of suitable seatings, and the provision of an associated locking arrangement, would prove difficult.

It is among the objects of one embodiment of the present invention to provide a robust and easily locked tilt adjustment arrangement suitable for use in a muzzle reference system.

According to a first aspect of the present invention there is provided a tilt adjustment arrangement comprising:-

a housing member defining a housing bearing surface having a single axis of rotational symmetry;

an eccentric member on the housing member rotatable only about said housing bearing axis and having an eccentric mating surface for engaging said housing bearing surface and defining an eccentric bearing surface with a single axis of rotational symmetry inclined at an eccentric offset angle to the axis of the said eccentric mating surface; and

a mounting member on the eccentric member rotatable only about said eccentric bearing axis and having a mounting mating surface for engaging the said eccentric bearing surface and further providing a mounting for an item to be adjusted, whereby rotation of the eccentric member relative to the housing changes the angular

disposition of the mounted item relative to the housing such that the mating axis of the mounting member lies in the surface of a cone described about the housing bearing axis and having an apex semi-angle equal to the eccentric offset angle.

This arrangement provides a simple yet effective means for tilting, with a single degree of freedom, the mounting member and thus the item to be adjusted mounted thereon, whilst allowing the mounting member to adopt any required degree of axial rotation relative to the housing, including continuous rotation.

According to a second aspect of the present invention there is provided a tilt adjustment arrangement comprising:-

a housing member defining a housing bearing surface having a single axis of rotational symmetry;

a first eccentric member on the housing member rotatable only about said housing bearing axis and having a first eccentric mating surface for engaging said housing bearing surface and defining a first eccentric bearing surface with a single axis of rotational symmetry inclined at a first eccentric offset angle to the axis of the said first eccentric mating surface;

a second eccentric member on the first eccentric member rotatable only about said first eccentric bearing axis and having a second eccentric mating surface for engaging said first eccentric bearing surface and defining a second eccentric bearing surface with a single axis of

rotational symmetry inclined at a second eccentric offset angle to the axis of the said second eccentric mating surface; and

5 a mounting member on the second eccentric member rotatable only about said second eccentric bearing axis and having a mounting mating surface for engaging the said second eccentric bearing surface and further providing a mounting for an item to be adjusted, whereby rotation of the first and/or second eccentric members relative to the housing changes the angular disposition of the mounted item relative to the housing such that the mating axis of the mounting member lies within the volume of an annular cone described about the housing bearing axis and having outer and inner apex semi-angles respectively equal to the sum and difference of the first and second eccentric offset angles.

10 This second arrangement provides an additional degree of freedom for adjusting the mounted item allowing the axis of the mounting member to lie anywhere within the volume of an annular cone described about the axis of the housing whilst allowing the mounting member to adopt any required degree of axial rotation relative to the housing, including continuous rotation.

20 The following statements apply equally to both aspects of the invention unless otherwise indicated.

25 Preferably, the corresponding bearing and mating surfaces of one or more of the members are cylindrical. Thus, the machining of the bearing and mating surfaces on

the members is relatively straightforward. The eccentric member would then conveniently have the form of a tube where the inner and outer cylindrical surfaces were inclined to each other at a small angle. As the contacting surface areas may be made relatively large, robust locking of the members to each other may be accomplished relatively easily, for example: adhesives may be applied to the contacting surfaces; or, by providing a longitudinal slit in the walls of all but the innermost member, a "pinch" clamp may be employed. As used herein, the term cylindrical is not intended to be limited to continuous surfaces nor perfect cylinders, but also encompass, for example, segmented surfaces, part cylinders and generally cylindrical polygonal forms. Further, the bearing and mating surfaces may, in general, be conical where the apex angle may vary from zero (a cylinder) to 180 degrees (a plane surface) without significant loss of machining advantage.

The housing may be in the form of a body, frame or any suitable arrangement which provides a mounting for the members, including an arrangement where the housing is the innermost element partly surrounded by the eccentric and mounting members.

The mounting member may provide a mounting for an item to be adjusted, such as an assembly containing optical elements; or it may form an integral part of the item to be adjusted, such as a mirror with a rear supporting spigot, or a rotating shaft extending through the eccentric member.

Preferably, the eccentric and mounting members include portions extending from the housing and which portions may be engaged to rotate the members relative to the housing. Further, the sensitivity of the adjustment may be selected by choosing corresponding eccentric bearing and mating axes of different relative inclinations.

These and other aspects of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a somewhat schematic representation of a tilt adjustment arrangement in accordance with an embodiment of the first aspect of the present invention;

Figure 2 is a somewhat schematic representation of a tilt adjustment arrangement in accordance with an embodiment of the second aspect of the present invention; and

Figure 3 is a somewhat schematic representation of a muzzle reference system incorporating a tilt adjustment arrangement in accordance with a preferred embodiment of the first aspect of the present invention.

Reference is first made to Figure 1 of the drawings which illustrates, somewhat schematically, a tilt adjustment arrangement 10 in accordance with an embodiment of the first aspect of the present invention. The arrangement 10 comprises a fixed housing 11 defining a cylindrical bore 12 and a tubular eccentric member 13 located within the bore 12 by means of an outer cylindrical surface 14 of a corresponding diameter, and further

defining an inner cylindrical bore 15. A mounting member 16 is rotatably mounted within the eccentric member 13 and itself provides mounting for an item to be adjusted (illustrated as an integral plane mirror 20). The mounting member 16 includes a cylindrical portion 17 for location within the eccentric member 13, and the bore 15 in the eccentric member 13 is of a corresponding diameter. However, it will be noted that axes 18, 19 of the outer and inner cylindrical surfaces respectively of the eccentric member 13 are inclined relative to one another.

In a typical use of the arrangement 10, the mounting member 16 carries a plane mirror 20 having a reflecting surface 21 tilted at a fixed small angle to the mounting member axis 19. It is desired to be able to adjust the attitude of the reflecting surface 21 relative to the housing 11. It will be noted that, simply by rotating the mirror and mounting member about the mounting member axis 19, the normal 22 to the mirror surface 21 can be made to sweep the surface of a cone 23 about the axis 19. Further, rotation of the eccentric tubular member 13 in the housing 11, about the housing axis 18, results in the axis 19 of the cone 23 sweeping the surface of a further cone 24. Thus by varying the rotary positions of the eccentric and mounting members relative to the housing, the normal 22 to the mirror surface 21 can be positioned anywhere within the total annular volume swept by the combined motions of the cones 23, 24. Further, if the relative inclination of the eccentric member axes 18, 19 is equal to the tilt of the

normal 22 to the mirror surface 21 relative to the mounting member axis 19 then the swept volume is a complete cone with an apex semi-angle equal to twice the mirror tilt. On reaching the desired mirror attitude, the mounting member 16 is locked relative to the eccentric member 13 and the eccentric member 13 is locked relative to the housing 11. This may be achieved by use of adhesive applied to the relatively large contacting surfaces between the members 11, 13, 16, or by including a pinch clamp in the housing 11.

Reference is now made to Figure 2 of the drawings which illustrates, somewhat schematically, a tilt adjustment arrangement in accordance with an embodiment of the second aspect of the present invention. As with the first aspect of the invention described above, the arrangement 30 includes a housing 31 defining a cylindrical bore 32. However, rather than the single tubular eccentric member 13 provided in the first described embodiment, this second embodiment includes first and second tubular eccentric members 33, 36. The first eccentric member 33 defines a cylindrical outer surface 34, for engaging the housing bore 32, and an inner bore 35, the axes of the surface 34 and bore 35 being inclined relative to one another. The second eccentric member 36 defines an outer cylindrical surface 37, for engaging the first eccentric member bore 35, and an inner bore 38 with an axis inclined relative to the axis of the outer surface 37. The mounting member is integral with the mounted item and comprises a

shaft 39 defining a cylindrical surface 40 for engaging the second eccentric member inner bore 38 with a common axis 41.

5 To facilitate location of the eccentric members 33, 36 in the housing 31, each member is provided with a lip 41, 42 at one end, which also facilitates rotation of the members.

10 The tilt of the shaft 39 is adjusted by rotating the inner second eccentric member 36 relative to the outer first eccentric member 33, and also by rotating the first eccentric member 33 relative to the housing 31. Once the shaft 39 is in the desired position the first eccentric member 33 is fixed relative to the second eccentric member 36, and the first eccentric member 33 fixed relative to the housing 31.

15 It will be noted from the above that these embodiments of the present invention provide a simple yet effective means for adjusting the tilt of an item. The use of cylindrical bearing surfaces allows the various parts to be machined easily using conventional machine tools, and the large contact areas between the bearing surfaces allow the arrangements to be robustly locked relatively easily. Further, the sensitivity of the arrangements may be selected simply by choosing axes of different relative inclinations: where the axes of the inner and outer surfaces of an eccentric member are close to parallel, relatively fine adjustment will be possible, whereas if the axes of the surfaces are inclined at a relatively large

angle, a large angle tilt adjustment range will be possible.

5 It will be further noted, that the shaft 39 may be free to rotate (for example, in bearings, not shown) in the eccentric member 36. In addition, if the shaft were to carry a mirror surface perpendicular to its axis 41, it could be permanently attached to the eccentric member 36 producing an adjustable arrangement equivalent to the first embodiment described above.

10 The present invention may be utilised in a wide range of applications, but an exemplary application of the invention will now be described with reference to Figure 3 of the accompanying drawings which illustrates, somewhat schematically, an electronic muzzle reference sensor system
15 50 for a tank which is arranged to provide an accurate indication of muzzle deflection, due to bending of the gun barrel, to an aiming computer (not shown) on board the tank. The Figure shows a gun barrel 51 which extends from the turret 52 of a tank. The barrel is able to recoil
20 through a protective mantelet 53 which otherwise elevates and depresses in harmony with the gun barrel. The muzzle reference system 50 comprises a mirror 54 which is rigidly attached to the muzzle 55 at the end of the gun barrel 51. At the opposite end of the gun barrel and rigidly fixed to
25 the gun mantelet 53 there is a housing 56 containing an optical radiation source, an adjacent detector arrangement and transmit and receive optics. A beam of light 57 generated by the light source is directed along the length

of the gun barrel so as to be incident on the mirror 54 and to be reflected thereby back towards the detector arrangement. The reflected light beam 58 is incident on the detector arrangement and causes an electrical output signal to be produced which varies as the reflected beam moves across the detection surface, for example, due to barrel bending.

In this example, the mirror 54 is mounted on an adjustment arrangement 59, similar to the arrangement 10 described above. When the muzzle reference system 50 is being fitted to the gun barrel 51, the adjustment arrangement housing is fixed securely to the muzzle 55. The arrangement is then adjusted to align the mirror 54 to the desired position. As noted above, this achieved by rotation of the first eccentric member 13 and the mirror shaft 16. When the mirror 54 is in the desired position the arrangement is locked.

This simple and robust adjustment arrangement is ideal for use in hostile environments, such as in muzzle reference systems, as described above.

It will be clear to those of skill in the art that the above-described embodiments are merely exemplary of the present invention and that various modifications and improvements may be made thereto, without departing from the scope of the invention. Further, it will be clear that the invention may be utilised in a wide range of applications where tilt adjustment is required, in addition to the muzzle reference system application described above.

CLAIMS

1. A tilt adjustment arrangement comprising:-

5 a housing member defining a housing bearing surface having a single axis of rotational symmetry;

10 an eccentric member on the housing member rotatable only about said housing bearing axis and having an eccentric mating surface for engaging said housing bearing surface and defining an eccentric bearing surface with a single axis of rotational symmetry inclined at an eccentric offset angle to the axis of the said eccentric mating surface; and

15 a mounting member on the eccentric member rotatable only about said eccentric bearing axis and having a mounting mating surface for engaging the said eccentric bearing surface and further providing a mounting for an item to be adjusted, whereby rotation of the eccentric member relative to the housing changes the angular
20 disposition of the mounted item relative to the housing such that the mating axis of the mounting member lies in the surface of a cone described about the housing bearing axis and having an apex semi-angle equal to the eccentric offset angle.

25 2. A tilt adjustment arrangement comprising:-

a housing member defining a housing bearing surface having a single axis of rotational symmetry;

a first eccentric member on the housing member rotatable only about said housing bearing axis and having a first eccentric mating surface for engaging said housing bearing surface and defining a first eccentric bearing surface with a single axis of rotational symmetry inclined at a first eccentric offset angle to the axis of the said first eccentric mating surface;

a second eccentric member on the first eccentric member rotatable only about said first eccentric bearing axis and having a second eccentric mating surface for engaging said first eccentric bearing surface and defining a second eccentric bearing surface with a single axis of rotational symmetry inclined at a second eccentric offset angle to the axis of the said second eccentric mating surface; and

a mounting member on the second eccentric member rotatable only about said second eccentric bearing axis and having a mounting mating surface for engaging the said second eccentric bearing surface and further providing a mounting for an item to be adjusted, whereby rotation of the first and/or second eccentric members relative to the housing changes the angular disposition of the mounted item relative to the housing such that the mating axis of the mounting member lies within the volume of an annular cone described about the housing bearing axis and having outer and inner apex semi-angles respectively equal to the sum and difference of the first and second eccentric offset angles.

3. The arrangement of claim 1 or 2, wherein at least one pair of corresponding bearing and mating surfaces are cylindrical.

5

4. The arrangement of claim 1, 2 or 3, wherein at least one eccentric member is a tube having inner and outer cylindrical surfaces inclined to one another.

10

5. The arrangement of any of the preceding claims wherein the members are lockable by application of adhesives to the respective contacting surfaces.

15

6. The arrangement of any of the preceding claims wherein a longitudinal slit is provided in the walls of one or more of members, to permit a pinch clamp to be employed to lock the members relative to one another.

20

7. The arrangement of any of the preceding claims, wherein at least one pair of corresponding bearing and mating surfaces are conical.

25

8. The arrangement of any of the preceding claims wherein the mounting member provides a mounting for an item to be adjusted.

9. The arrangement of claim 8, wherein the mounting member provides a mounting for an assembly containing optical elements.

10. The arrangement of any of claims 1 to 7 wherein the mounting member forms an integral part of the item to be adjusted.

5 11. The arrangement of claim 10 wherein the item to be adjusted is a mirror with a rear supporting spigot.

10 12. The arrangement of any of the preceding claims wherein the eccentric and mounting members include portions extending from the housing and which portions may be engaged to rotate the members relative to the housing.

15 13. A muzzle reference system incorporating the arrangement of any of the preceding claims.

14. The arrangement of claim 10 wherein the item to be adjusted is a rotating shaft extending through the eccentric member.

20 15. A tilt adjustment arrangement substantially as described herein and as illustrated in Figure 1 or Figure 2 of the accompanying drawings.

25 16. A muzzle reference system substantially as described herein and as illustrated in Figure 3 of the accompanying drawings.



Application No: GB 9619293.5
Claims searched: 1 to 16

Examiner: Trevor Berry
Date of search: 5 November 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F3C (CTA, CGB), E2F (FCC, FCE), G2J (JMM, JRD)

Int Cl (Ed.6): F16C, F41G, GO2B

Other: ONLINE: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 1571903	DEFENCE SECRETARY	1,8
X	GB 1557819	RCA	1, 8, 9
X	GB 1563316	FORD	1-3, 8
X	GB 1052395	PHILIPS ELECTRONICS	1, 7-12
X	GB 0411160	BROWN	1-3, 8
X	US 4990050	TOKICO	1-3, 8
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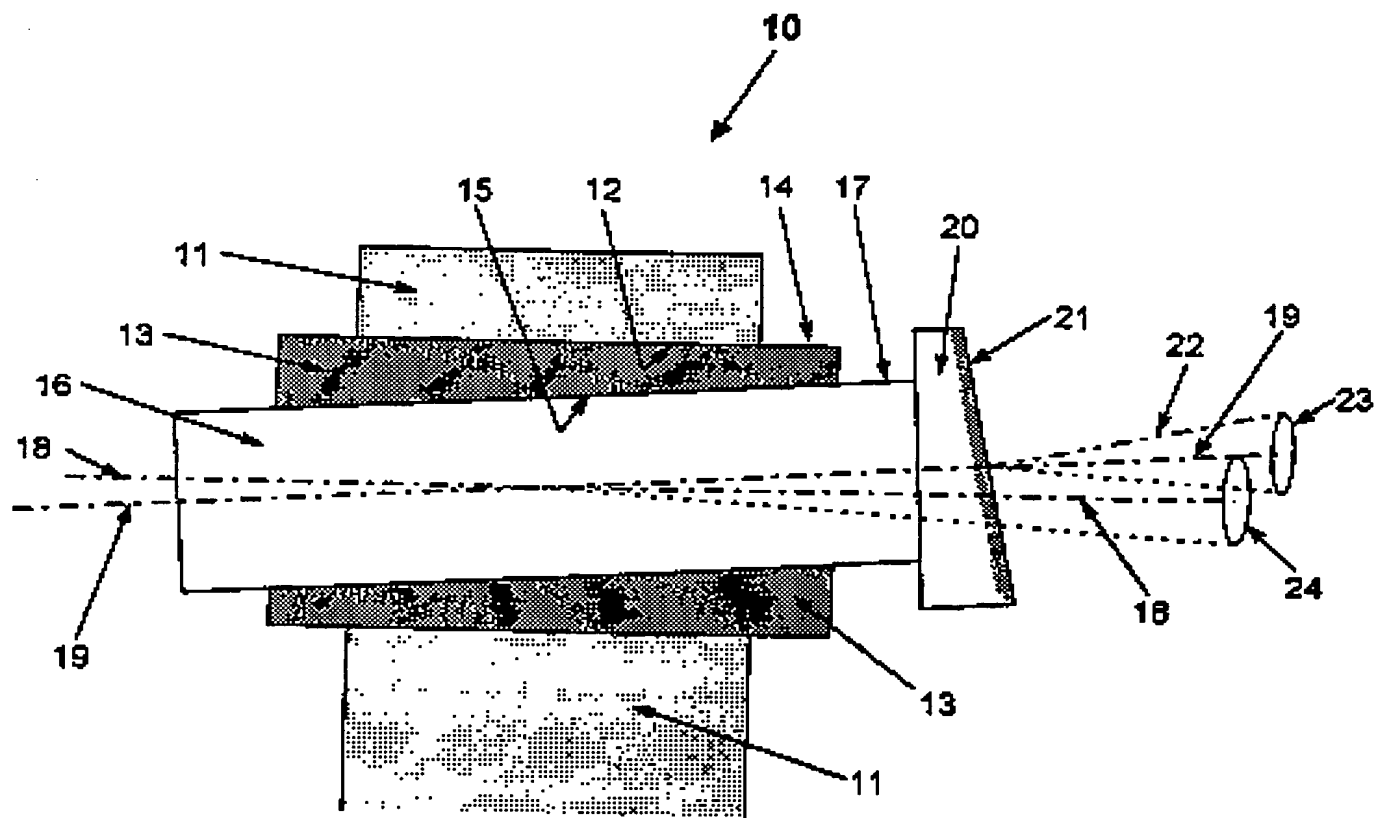


Figure 1

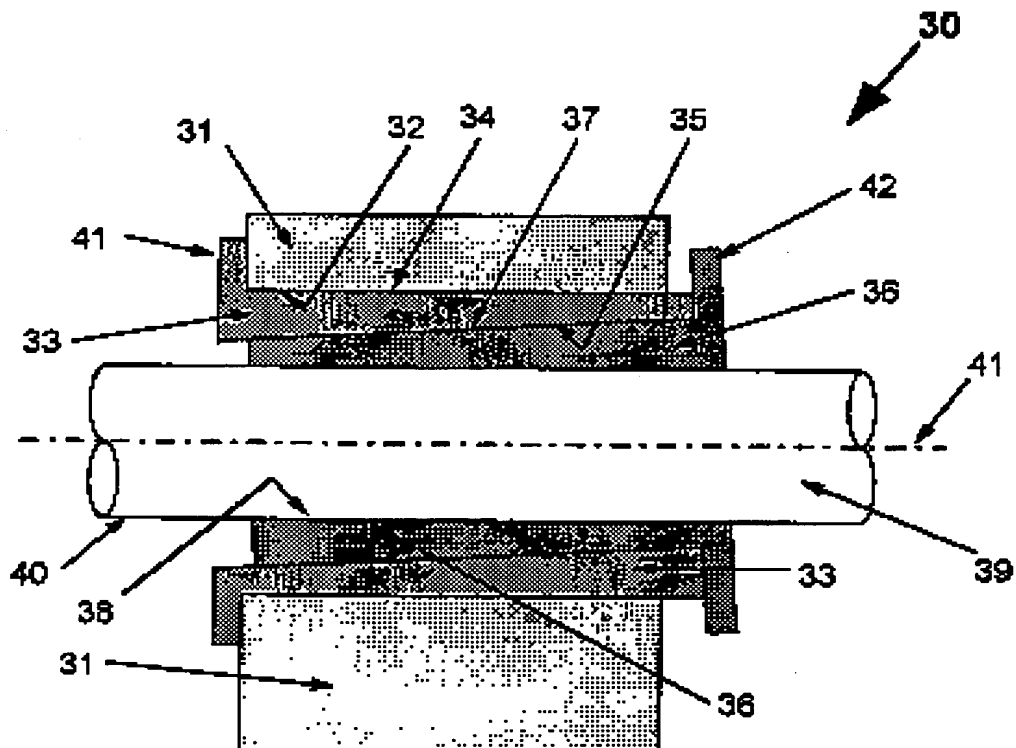


Figure 2

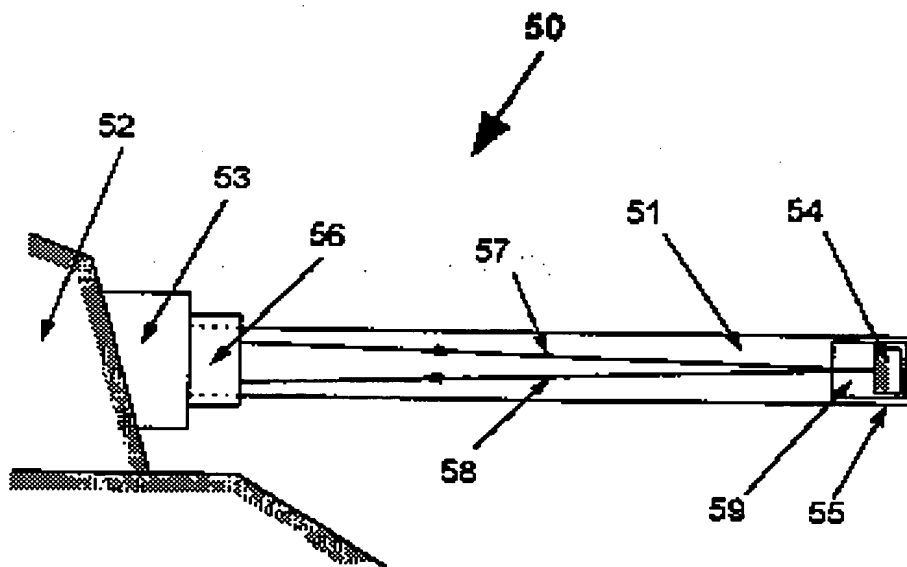


Figure 3

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